What is claimed is:

CLAIMS

1. An optical switching method for switching to a destination route upstream optical signal samples that are obtained from a first source by a spread spectrum technique, and upstream optical signal samples that are obtained from additional NCC sources and comprise at least one of the following: upstream optical signal samples that are separately obtained from NS out of the NCC sources by said spread spectrum technique; and n series of upstream optical signal samples that are separately obtained from n out of the NCC sources and are carried over n discrete channel wavelengths, wherein the upstream optical signal samples obtained from said first source are provided at a data rate DRS, the upstream optical signal samples obtained from the NS sources are provided at data rates $DRSS_j$, and each series of upstream optical signal samples in the n series of upstream optical signal samples is carried over a discrete channel wavelength λ_i at a data rate DR_i, where each of NCC, n and NS is an integer greater than or equal to one, i is an index running from 1 to n, and j is an index running from 1 to NS, the method comprising:

optically converting said upstream optical signal samples that are obtained from said first source and said upstream optical signal samples that are obtained from said additional NCC sources into a broadband combined series of upstream optical signal samples at a combined data rate DR_c which is greater than any of the following: DRS; any separate $DRSS_j$; and any separate DR_i; and

routing said broadband combined series of upstream optical signal samples to said destination route.

2. A method according to claim 1 and wherein each of said upstream optical signal samples obtained from the first source and said upstream optical signal samples obtained from the NS sources comprises upstream optical signal samples that occupy a wavelength band, and said optically converting comprises:

dropping said upstream optical signal samples obtained from the first source and at least one of the following: said upstream optical signal samples that are separately obtained from said NS sources, and the n series of upstream optical signal samples;

converting the dropped upstream optical signal samples obtained from the first source into a first series of upstream optical signal samples centered around a channel wavelength λ_D, and respectively converting at least one of the following: the dropped upstream optical signal samples that are separately obtained from said NS sources into NS series of upstream optical signal samples centered around said channel wavelength λ_D, and any of the λ_i that differ from λ_D to λ_D thereby forming a group of n series of upstream optical signal samples having the upstream optical signal samples carried over λ_D; and

combining the following to obtain said broadband combined series of upstream optical signal samples: all said series of upstream optical signal samples centered around said channel wavelength λ_D; and the n series of upstream optical signal samples in said group.

3. A method according to claim 2 and also comprising selecting said channel wavelength λ_D prior to said converting.

4. A method according to claim 1 and wherein each of said upstream optical signal samples obtained from the first source and said upstream optical signal samples obtained from the NS sources comprises upstream optical signal samples that are randomly spread in a plurality of bands around a plurality of wavelengths, and said optically converting comprises:

dropping said upstream optical signal samples obtained from the first source and at least one of the following: said upstream optical signal samples that are separately obtained from said NS sources, and the n series of upstream optical signal samples;

converting the dropped upstream optical signal samples obtained from the first source into a first broadband series of upstream optical signal samples and respectively converting at least one of the following: the dropped upstream optical signal samples that are separately obtained from said NS sources into NS broadband series of upstream optical signal samples, and any of the λ_i to a channel wavelength λ_D thereby forming a group of n series of upstream optical signal samples having the upstream optical signal samples carried over λ_D; and

respectively combining the following to obtain said broadband combined series of upstream optical signal samples: the first broadband series of upstream optical signal samples, the NS broadband series of upstream optical signal samples, and the n series of upstream optical signal samples in said group.

5. A method according to claim 1 and wherein said destination route comprises at least one of the following: a destination fiber optic cable capable of carrying optical signal samples at said combined data rate DR_c; a wireless communication route; a waveguide; a transmission line; an interface to a destination optical transceiver; and an interface to a destination optical communication system capable of operating at said combined data rate DR_c.

6. An optical switching method for switching to nn routes a broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique, where nn is an integer greater than one and the broadband series of downstream optical signal samples is provided at a data rate DR_T, the method comprising:

optically converting the broadband series of downstream optical signal samples into nn series of downstream optical signal samples at data rates $DRT_1,\ldots,DRT_{nn}$, the nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples; and NST series of downstream optical signal samples having the downstream optical signal samples carried over discrete channel wavelengths, where

each of nn, NT and NST is an integer greater than or equal to one, and each of $DRT_1, \ldots, DRT_{nn}$ is less than DR_T; and

routing said nn series of downstream optical signal samples to the nn routes respectively.

7. A method according to claim 6 and wherein said broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique comprises downstream optical signal samples that occupy a wavelength band, and said optically converting comprises:

separating said broadband series of downstream optical signal samples into nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples centered around a channel wavelength λ_T, and NST series of downstream optical signal samples each having the downstream optical signal samples carried over λ_T;

respectively converting at least one of the following: the NT broadband series of downstream optical signal samples centered around λ_T into NT broadband series of downstream optical signal samples centered around NT channel wavelengths of which NT-1 channel wavelengths are different from λ_T, and said NST series of downstream optical signal samples into NST series of downstream optical signal samples having the downstream optical signal samples carried over NST channel wavelengths of which NST-1 channel wavelengths are different from λ_T; and

respectively adding said NT broadband series of downstream optical signal samples centered around NT channel wavelengths to NT routes of said nn routes, and said NST series of downstream optical signal samples carried over the NST channel wavelengths to NST routes of said nn routes.

8. A method according to claim 6 and wherein said broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique

comprises downstream optical signal samples that are randomly spread in a plurality of bands around a plurality of wavelengths, and said optically converting comprises:

separating said broadband series of downstream optical signal samples into nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples, and NST series of downstream optical signal samples each having the downstream optical signal samples carried over λ_T;

respectively converting at least one of the following: the NT broadband series of downstream optical signal samples into NT broadband series of downstream optical signal samples randomly spread in a plurality of bands around a plurality of wavelengths, and said NST series of downstream optical signal samples into NST series of downstream optical signal samples having the downstream optical signal samples carried over NST channel wavelengths of which NST-1 channel wavelengths are different from λ_T; and

respectively adding said NT broadband series of downstream optical signal samples randomly spread in a plurality of bands around a plurality of wavelengths to NT routes of said nn routes, and said NST series of downstream optical signal samples carried over the NST channel wavelengths to NST routes of said nn routes.

9. An optical switching apparatus that switches to a destination route upstream optical signal samples that are obtained from a first source by a spread spectrum technique, and upstream optical signal samples that are obtained from additional NCC sources and comprise at least one of the following: upstream optical signal samples that are separately obtained from NS sources by said spread spectrum technique; and n series of upstream optical signal samples that are separately obtained from n sources and are carried over n discrete channel wavelengths, wherein the upstream optical signal samples obtained from said first source are provided at a data rate DRS, the upstream optical signal samples obtained from the NS sources are provided at data rates $DRSS_j$, and each series of upstream optical signal samples in

the n series of upstream optical signal samples is carried over a discrete channel wavelength λ_i at a data rate DR_i, where each of NCC, n and NS is an integer greater than or equal to one, i is an index running from 1 to n, and j is an index running from 1 to NS, the apparatus comprising:

an upstream optical converter unit operative to convert said upstream optical signal samples that are obtained from said first source and said upstream optical signal samples that are obtained from said additional NCC sources into a broadband combined series of upstream optical signal samples at a combined data rate DR_c which is greater than any of the following: DRS; any separate $DRSS_j$; and any separate DR_i; and

an upstream router operatively associated with the upstream optical converter unit and operative to route said broadband combined series of upstream optical signal samples to said destination route.

10. Apparatus according to claim 9 and wherein each of said upstream optical signal samples obtained from the first source and said upstream optical signal samples obtained from the NS sources comprises upstream optical signal samples that occupy a wavelength band, and said upstream optical converter unit comprises:

a multiplexing/demultiplexing unit comprising:

a grouped add-drop multiplexer (GADM) which is operative to drop said upstream optical signal samples obtained from the first source, and

at least one of the following: NS grouped ADMs operative to drop said upstream optical signal samples that are separately obtained from said NS sources, and at least one ADM operative to drop the n series of upstream optical signal samples;

an upstream wavelength converter unit operatively associated with the multiplexing/demultiplexing unit and comprising:

a broadband wavelength converter operatively associated with the GADM and operative to convert the upstream optical signal samples obtained

from the first source that are dropped by the GADM into a first series of upstream optical signal samples centered around a channel wavelength λ_D, and

at least one of the following: NS broadband wavelength converters operatively associated with the NS grouped ADMs and operative to convert the dropped upstream optical signal samples that are separately obtained from said NS sources into NS series of upstream optical signal samples centered around said channel wavelength λ_D, and at least one wavelength converter operative to convert any of the λ_i that differ from λ_D to λ_D thereby forming a group of n series of upstream optical signal samples having the upstream optical signal samples carried over λ_D; and

a combiner operatively associated with the upstream wavelength converter unit and operative to obtain said broadband combined series of upstream optical signal samples by combining the following: all said series of upstream optical signal samples centered around said channel wavelength λ_D; and the n series of upstream optical signal samples in said group.

11. Apparatus according to claim 9 and wherein each of said upstream optical signal samples obtained from the first source and said upstream optical signal samples obtained from the NS sources comprises upstream optical signal samples that are randomly spread in a plurality of bands around a plurality of wavelengths, and said upstream optical converter unit comprises:

a multiplexing/demultiplexing unit comprising:

a random add-drop multiplexer (RADM) which is operative to drop said upstream optical signal samples obtained from the first source, and

at least one of the following: NS random ADMs operative to drop said upstream optical signal samples that are separately obtained from said NS sources, and at least one ADM operative to drop the n series of upstream optical signal samples;

an upstream wavelength converter unit operatively associated with the multiplexing/demultiplexing unit and comprising:

a broadband wavelength converter operatively associated with the RADM and operative to convert the upstream optical signal samples obtained from the first source that are dropped by the RADM into a first broadband series of upstream optical signal samples, and

at least one of the following: NS broadband wavelength converters operatively associated with the NS random ADMs and operative to convert the dropped upstream optical signal samples that are separately obtained from said NS sources into NS broadband series of upstream optical signal samples, and at least one wavelength converter operative to convert any of the λ_i to a channel wavelength λ_D thereby forming a group of n series of upstream optical signal samples having the upstream optical signal samples carried over λ_D; and

a combiner operatively associated with the upstream wavelength converter unit and operative to obtain said broadband combined series of upstream optical signal samples by respectively combining the following: the first broadband series of upstream optical signal samples, the NS broadband series of upstream optical signal samples, and the n series of upstream optical signal samples in said group.

12. An optical switching apparatus that switches to nn routes a broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique, where nn is an integer greater than one and the broadband series of downstream optical signal samples is provided at a data rate DR_T, the apparatus comprising:

a downstream optical converter unit operative to convert the broadband series of downstream optical signal samples into nn series of downstream optical signal samples at data rates $DRT_1,\ldots,DRT_{nn}$, the nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples; and NST series of downstream optical signal samples having the downstream optical signal samples carried over discrete channel

wavelengths, where each of nn, NT and NST is an integer greater than or equal to one, and each of $DRT_1, \ldots, DRT_{nn}$ is less than DR_T; and

a downstream router operatively associated with the downstream optical converter unit and operative to route said nn series of downstream optical signal samples to the nn routes respectively.

13. Apparatus according to claim 12 and wherein said broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique comprises downstream optical signal samples that occupy a wavelength band, and said downstream optical converter unit comprises:

a demultiplexer operative to separate said broadband series of downstream optical signal samples into nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples centered around a channel wavelength λ_T, and NST series of downstream optical signal samples each having the downstream optical signal samples carried over λ_T;

a downstream wavelength converter unit operatively associated with the demultiplexer and comprising at least one of the following: NT broadband wavelength converters operative to convert the NT broadband series of downstream optical signal samples centered around λ_T into NT broadband series of downstream optical signal samples centered around NT channel wavelengths of which NT-1 channel wavelengths are different from λ_T, and at least one wavelength converter operative to convert said NST series of downstream optical signal samples into NST series of downstream optical signal samples having the downstream optical signal samples carried over NST channel wavelengths of which NST-1 channel wavelengths are different from λ_T; and

a multiplexing/demultiplexing unit comprising at least one of the following: NT grouped add-drop multiplexers (GADMs) operative to add said NT broadband series of downstream optical signal samples centered around NT channel wavelengths to NT routes of said nn routes respectively; and NST add-drop

multiplexers operative to add said NST series of downstream optical signal samples carried over the NST channel wavelengths to NST routes of said nn routes respectively.

14. Apparatus according to claim 12 and wherein said broadband series of downstream optical signal samples obtained by utilizing a spread spectrum technique comprises downstream optical signal samples that are randomly spread in a plurality of bands around a plurality of wavelengths, and said downstream optical converter unit comprises:

a demultiplexer operative to separate said broadband series of downstream optical signal samples into nn series of downstream optical signal samples comprising at least one of the following: NT broadband series of downstream optical signal samples, and NST series of downstream optical signal samples each having the downstream optical signal samples carried over λ_T;

a downstream wavelength converter unit operatively associated with the demultiplexer and comprising at least one of the following: NT broadband wavelength converters operative to convert the NT broadband series of downstream optical signal samples into NT broadband series of downstream optical signal samples randomly spread in a plurality of bands around a plurality of wavelengths, and at least one wavelength converter operative to convert said NST series of downstream optical signal samples into NST series of downstream optical signal samples having the downstream optical signal samples carried over NST channel wavelengths of which NST-1 channel wavelengths are different from λ_T; and

a multiplexing/demultiplexing unit comprising at least one of the following: NT random add-drop multiplexers (RADMs) operative to add said NT broadband series of downstream optical signal samples randomly spread in a plurality of bands around a plurality of wavelengths to NT routes out of said nn routes respectively; and NST add-drop multiplexers operative to add said NST series of downstream optical signal samples carried over the NST channel wavelengths to NST routes out of said nn routes respectively.

15. An optical communication signal useful for communication to at least one of a node server and an end node of an optical communication network, the optical communication signal comprising a broadband series of optical signal samples having the optical signal samples carried at a data rate DR_c, the broadband series of optical signal samples being produced by optically converting optical signal samples that are obtained from a first source by a spread spectrum technique, and optical signal samples that are obtained from additional NCC sources and comprise at least one of the following: optical signal samples that are separately obtained from NS out of the NCC sources by said spread spectrum technique; and n series of optical signal samples that are separately obtained from n out of the NCC sources and are carried over n discrete channel wavelengths, wherein the optical signal samples obtained from said first source are provided at a data rate DRS, the optical signal samples obtained from the NS sources are provided at data rates $DRSS_j$, and each series of optical signal samples in the n series of optical signal samples has the optical signal samples carried at a data rate DR_i, where each of NCC, n and NS is an integer greater than or equal to one, i is an index running from 1 to n, and j is an index running from 1 to NS, and DR_c is greater than any of the following: DRS; any separate $DRSS_j$; and any separate DR_i.

16. A communication network comprising a node server, a plurality of end nodes, and a communication switch comprising the optical switching apparatus of claim 9 in operative association with the node server and the plurality of end nodes.

17. A communication network comprising a node server, a plurality of end nodes, and a communication switch comprising the optical switching apparatus of claim 12 in operative association with the node server and the plurality of end nodes.